Claims

What is claimed:

1. A semiconductor device, comprising:

a drain electrode;

a source electrode;

a channel contacting the drain electrode and the source electrode, wherein the channel includes gallium oxide;

a gate electrode; and

a gate dielectric positioned between the gate electrode and the channel.

2. The semiconductor device of claim 1, wherein gallium oxide includes a single-phase crystalline form selected from the group consisting of GaO, Ga_2O, and Ga_2O_3.

3. The semiconductor device of claim 1, wherein gallium oxide includes a single-phase crystalline form of β-Ga_2O_3.

4. The semiconductor device of claim 1, wherein gallium oxide includes a mixed-phase crystalline form from compounds selected from the group consisting of GaO, Ga_2O, Ga_2O_3, and mixtures thereof.

5. The semiconductor device of claim 4, wherein gallium oxide includes GaO:Ga_2O:Ga_2O_3 in a ratio of A:B:C, wherein A, B, and C are each in a range of about 0.025 to about 0.95.

6. The semiconductor device of claim 1, wherein gallium oxide includes an amorphous form from compounds selected from the group consisting of GaO, Ga_2O, Ga_2O_3, and mixtures thereof.

7. The semiconductor device of claim 1, wherein the channel includes being positioned between and electrically coupling the drain electrode and the source electrode.

8. The semiconductor device of claim 1, wherein at least one of the drain electrode, the source electrode, the channel, and gate electrode, and the gate dielectric are substantially transparent.

9. A semiconductor device, comprising:

a drain electrode;

a source electrode;

means for a channel to electrically couple the drain electrode and the source electrode;

a gate electrode; and

a gate dielectric positioned between the gate electrode and the channel.

10. The semiconductor device of claim 9, wherein the means for a channel includes means for a single-phase crystalline form selected from the group consisting of GaO, Ga_2O, and Ga_2O_3.

11. The semiconductor device of claim 9, wherein the means for a channel includes a single-phase crystalline form of β-Ga_2O_3.

12. The semiconductor device of claim 9, wherein the means for a channel includes means for forming a mixed-phase crystalline form from compounds selected from the group consisting of GaO, Ga_2O, Ga_2O_3, and mixtures thereof.

13. The semiconductor device of claim 9, wherein the means for a channel includes means for forming an amorphous form from compounds selected from the group consisting of GaO, Ga_2O, Ga_2O_3, and mixtures thereof.

14. The semiconductor device of claim 9, wherein at least one of the drain electrode, the source electrode, the channel, and gate electrode, and the gate dielectric are substantially transparent.

15. A method of forming a semiconductor device, comprising:

providing a drain electrode;

providing a source electrode;

depositing a channel contacting the drain electrode and the source electrode and including gallium oxide;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

16. The method of claim 15, wherein depositing a channel includes:

vaporizing a precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

17. The method of claim 16, wherein the physical vapor deposition technique includes one or more of dc sputtering, rf sputtering, magnetron sputtering, and ion beam sputtering.

18. The method of claim 15, wherein depositing the channel includes depositing the precursor composition with an ink-jet deposition technique.

19. The method of claim 15, wherein depositing a channel includes:

providing a precursor composition including one or more zinc precursor compounds and indium precursor compounds and;

depositing the channel from the precursor composition.

20. The method of claim 15, including providing a substrate or substrate assembly; and

forming the semiconductor device on the substrate or substrate assembly.

21. A method of manufacturing a semiconductor device, comprising:

providing a drain electrode;

providing a source electrode;

step for providing a precursor composition including one or more compounds of a gallium precursor compound;

step for depositing a channel of gallium oxide from the precursor composition contacting the drain electrode and the source electrode;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

22. The method of claim 21, wherein the step for depositing includes:

step for vaporizing the precursor composition to form vaporized precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

23. The method of claim 22, wherein the physical vapor deposition technique includes one or more of dc sputtering, rf sputtering, magnetron sputtering, and ion beam sputtering.

24. The method of claim 21, wherein the step for depositing the channel includes the step for depositing the precursor composition with an ink-jet deposition technique.

25. A method of forming a channel, comprising:

providing a precursor composition including one or more compounds of a gallium precursor compound; and

depositing the channel of gallium oxide from the precursor composition between and electrically coupling a drain electrode and a source electrode.

26. The method of claim 25, wherein depositing the channel includes

vaporizing the precursor composition to form vaporized precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

27. The method of claim 26, wherein the physical vapor deposition technique includes one or more of dc sputtering, rf sputtering, magnetron sputtering, and ion beam sputtering.

28. A semiconductor device formed by the steps, comprising:

providing a drain electrode;

providing a source electrode;

providing a precursor composition including one or more compounds of a gallium precursor compound;

depositing a channel of gallium oxide from the precursor composition to contact the drain electrode and the source electrode;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

29. The semiconductor device of claim 28, wherein depositing the channel includes:

vaporizing the precursor composition to form vaporized precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

30. The semiconductor device of claim 28, wherein the physical vapor deposition technique includes one or more of dc sputtering, rf sputtering, magnetron sputtering, and ion beam sputtering.

31. A method for operating a semiconductor device, comprising:

providing a semiconductor device that includes a drain electrode, a source electrode, a channel to electrically couple the drain electrode and the source electrode, wherein the channel includes gallium oxide, a gate electrode, and a gate dielectric positioned between the gate electrode and the channel; and

applying a voltage to the gate electrode to effect a flow of electrons through the gallium oxide of the channel.

32. The method of claim 31, wherein applying a voltage includes using the semiconductor device as a switch in a display device.

33. The method of claim 31, wherein applying a voltage includes conducting electrons through a channel of a gallium oxide in a linear region of operation.

34. A display device, comprising:

a plurality of display elements configured to operate collectively to display images, where each of the display elements includes a semiconductor device configured to control light emitted by the display element, the semiconductor device including:

a drain electrode;

a source electrode;

a channel contacting the drain electrode and the source electrode, wherein the channel includes gallium oxide;

a gate electrode; and

a gate dielectric positioned between the gate electrode and the channel and configured to permit application of an electric field to the channel.

35. The display device of claim 34, wherein gallium oxide includes a single-phase crystalline form selected from the group consisting of GaO, Ga_2O, and Ga_2O_3.

36. The display device of claim 34, wherein gallium oxide includes a single-phase crystalline form of β-Ga_2O_3.

37. The display device of claim 34, wherein gallium oxide includes a mixed-phase crystalline form from compounds selected from the group consisting of GaO, Ga_2O, Ga_2O_3, and mixtures thereof.

38. The display device of claim 37, wherein gallium oxide includes $GaO:Ga_2O:Ga_2O_3$ in a ratio of A:B:C, wherein A, B, and C are each in a range of about 0.025 to about 0.95.

39. The display device of claim 34, wherein gallium oxide includes an amorphous form from compounds selected from the group consisting of GaO, Ga_2O, Ga_2O_3, and mixtures thereof.

40. The display device of claim 34, wherein at least one of the drain electrode, the source electrode, the channel, and gate electrode, and the gate dielectric are substantially transparent.